IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of	:	PATENT
William SETTER et al.	:	Confirmation No. 4584
Serial No.: 10/767,190	:	Docket No. 119508-00102
Filed: January 30, 2004	:	Customer No. 27557
For: SYSTEM AND METHOD FOR CONTROLLING AN IMPACT TOOL	:	Art Unit: 3721
	:	Examiner: N. C. Chukwurah

APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sirs:

The present Appeal Brief is submitted further to the Notice of Appeal filed October 2, 2007, and in response to the Notice of Panel Decision from Pre-Appeal Brief Review mailed October 26, 2007.

I. Real Party In Interest

Methode Electronics, Inc. is the assignee and real party in interest.

II. Related Appeals and Interferences

There are no other related appeals or interferences known to Appellants, Appellants' legal representative, or Assignee, which would directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims

Claims 1-26 are pending in this application. See Section VIII, Claims Appendix, for a listing of the claims. Claims 1-26 stand finally rejected and form the subject matter of the present appeal. In the final Office Action dated July 19, 2007, claims 1-3, 7-13 and 17-23 are rejected under 35 U.S.C. 102(b) as allegedly being anticipated by U.S. Patent No. 6,311,786 to Giardino et al. (hereinafter "Giardino et al."), and claims 4-6, 14-16 and 24-26 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Giardino et al.

IV. Status of Amendments

No amendment was filed subsequent to the final rejection of July 19, 2007.

V. Summary of Claimed Subject Matter

The invention relates to a method for dynamically calculating the torque being applied to a fastener by an impact tool using the characteristics of individual pulses over a period of time. The method provides better control of the impact tool and prevents under and over tightening of the fastener.

As seen in Fig. 3, an impact tool 30 includes a body 302, a shaft 304 connected thereto and a torque transducer 306 surrounding the shaft 304. The shaft 304 is adapted to be coupled to a fastener 40, such as by using an anvil attached to the end of the shaft. The torque transducer 306 produces a magnetic field proximate the shaft 304 in relation to the amount of torque being applied to the shaft 304. A controller 310 includes circuits adapted to perform the functions of digitizing and parsing the pulse signals.

After applying a torque pulse to the fastener, the method provides for detecting the signal representing the time-amplitude waveform of the torque pulse, as seen in Fig. 2. Fig. 2 illustrates the time-amplitude waveform of a single pulse produced by the impact tool. As seen in Fig. 2, the stress represented by a single pulse is proportional to the torque on the fastener at the time of impact and is also proportional to the static torque on the fastener after tightening is completed. For example, when the impact tool 30 applies a tightening torque to the fastener 40, the signal response would be similar to that shown in Fig. 2, with the primary pulse, determined by the output from the torque transducer 306, being above 2.5 VDC (i.e., zero volts, normalized), and the secondary pulse being less than 2.5 VDC. See col. 9, lines 12-21 of Appellants' disclosure.

Next, the controller 310 executes a series of routines to fit a number of different equations to find the best *one* that approximates the torque pulse waveform. See page 10, lines

17-20 and Figs. 4, and 5a-5d. After processing the selected equation to determine the torque being applied to the fastener, that torque value is compared to a pre-determined torque objective. Finally, a second torque pulse is applied to the fastener if the torque objective was not met.

Independent claim 1 recites the following:

A method for determining the torque applied to a fastener comprising the steps of:

applying a torque pulse to a fastener (see page 10, line 14 of Appellants' disclosure);

detecting a signal representing the time-amplitude waveform of the torque pulse (see page 10, lines 15-16 of Appellants' disclosure; Fig. 2);

fitting an equation that approximates the time-amplitude waveform by selecting one mathematical expression from a set of mathematical expressions and selecting at least one parameter that describes the torque pulse from a set of parameters (see page 10, lines 17-19 of Appellants' disclosure);

processing the equation to determine the torque being applied to the fastener (see page 10, lines 19-20 of Appellants' disclosure);

comparing the torque to a pre-set torque objective (see page 10, lines 20-22 of Appellants' disclosure); and

applying a second torque pulse to the fastener if the torque is less than the pre-set torque objective (see page 10, lines 22-25 of Appellants' disclosure).

Independent claim 11 recites the following:

A method for determining the torque applied to a fastener comprising the steps of:

applying a plurality of torque pulses to a fastener during a fastener tightening sequence,

wherein the torque pulses have a duration and amplitude (see page 6, lines 14-16, and page 10, lines 14 of Appellants' disclosure);

detecting a signal representing the time-amplitude waveform shapes of each of the torque pulses (see page 10, lines 15-16 of Appellants' disclosure);

converting the signals into mathematical expressions representing each of the torque pulses, wherein each mathematical expressions is selected from a set of mathematical expressions and include parameters representing at least the amplitude and duration of the torque pulses (see page 6, lines 19-20, and page 10, lines 17-19 of Appellants' disclosure);

processing the mathematical expressions to obtain the torque applied to the fastener during the torque pulses (see page 10, lines 19-20 of Appellants' disclosure); and

terminating the fastener tightening sequence if the torque is approximately equal to a pre-set torque objective (see page 6, line 21 and page 10, lines 22-25 of Appellants' disclosure).

Independent claim 21 recites the following:

An apparatus for producing a plurality of torque pulses during a tightening sequence of a fastener comprising:

an impact tool (see Fig. 3, reference numeral "30");

a shaft operatively connected to the impact tool (see Fig. 3, reference numeral "304");

a torque transducer coupled to the shaft (see Fig. 3, reference numeral "306");

a sensor proximate the torque transducer (see page 8, line 6 of Appellants' disclosure); and

a controller (see Fig. 3, reference numeral "310"),

wherein the controller enables the impact tool, applies one or more pulses to the shaft,

receives waveform signals from the sensor, monitors and conditions the signals (see page 9, lines 22-25, and page 10 lines 1-10 of Appellants' disclosure); selects an equation that approximates the signals by selecting a mathematical expression from a set of mathematical expressions and selecting at least one parameter that describes the torque pulse from a set of parameters (see page 10, lines 17-19 of Appellants' disclosure); processes the equation to obtain the torque on the fastener (see page 10, lines 19-20 of Appellants' disclosure); and disables the impact tool, and wherein the equation represents the time-amplitude curve of the one or more pulses and includes parameters for the amplitude, duration and the area under the time-amplitude curve (see page 10, lines 15-16 of Appellants' disclosure).

VI. Grounds of Rejection To Be Reviewed On Appeal

Whether claims 1-3, 7-13 and 17-23 are anticipated by U.S. Patent No. 6,311,786 to Giardino et al. under 35 U.S.C. 102(b); and whether claims 4-6, 14-16 and 24-26 are unpatentable over Giardino et al. under 35 U.S.C. 103(a).

VII. Argument

A. Summary of Argument

A prima facie case of anticipation has not been established with respect to claims 1-3, 7-13 and 17-23 because all of the claim limitations of independent claims 1, 11 and 21 are not identically found in Giardino et al. Also, a prima facie case of obviousness has not been established with respect to claims 4-6, 14-16 and 24-26 because all of their claim limitations are neither found in nor rendered obvious by Giardino et al. More specifically, Giardino et al. fails to disclose, teach or suggest a method for determining the torque applied to a fastener including the step of fitting an equation that approximates torque "by selecting *one* mathematical expression from a *set* of mathematical expressions" as recited in the claimed invention.

B. Summary of Rejection

Claims 1-3, 7-13 and 17-23 are rejected under 35 U.S.C. 102(b) as allegedly being anticipated by Giardino et al., and claims 4-6, 14-16 and 24-26 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Giardino et al. Giardino et al. is interpreted as disclosing applying a torque pulse to a fastener; detecting a signal representing the time-amplitude waveform of the pulse; fitting an equation that approximates the time amplitude waveform, processing the equation; comparing the torque to a pre-set torque objective; and applying a second torque. The Examiner suggests that although Giardino et al. does not expressly teach selecting one mathematical expression from a set of mathematical expressions that approximates the time-amplitude waveform, as recited in the claimed invention, the method

of Giardino et al. is nonetheless "capable of having different preprogrammed sets of mathematical torque expressions" because Giardino et al.'s method includes using impulse and angular momentum equations to calculate torque. As detailed below, however, the impulse and angular momentum equations do not meet the limitations of the claimed invention.

C. Applicable Law

Anticipation requires that every limitation of a claim must identically appear in a prior art reference. See *Gechter v. Davidson*, 43 U.S.P.Q. 2d 1030, 1032 (Fed. Cir. 1997). Absence from the prior art reference of any claimed element negates anticipation. See *Rowe v. Dror*, 42 U.S.P.Q.2d 1550, 1553 (Fed. Cir. 1997). Also, "to establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745, 49 U.S.P.Q.2d 1949, 1950-51 (Fed. Cir. 1999).

D. Error to Reject Claims 1-3, 7-13 and 17-23 Under 35 U.S.C. 102(b)

Claims 1-3, 7-13 and 17-23 stand rejected under 35 U.S.C. 102(b) as allegedly being anticipated by U.S. Patent No. 6,311,786 to Giardino et al. Giardino et al., however, fails to disclose, teach or suggest determining torque including the step of fitting an equation that approximates the time-amplitude waveform of the torque pulse by selecting one mathematical expression from a set of mathematical expressions, as recited in claim invention. The claimed

invention not only requires multiple expressions, but also requires the ability to select one expression from the multiple expressions.

(1) The Impulse and Angular Momentum Equations of Giardino et al. Do Not Provide A Set of Mathematical Expressions From Which a Torque Expression is Selected As Required By The Claimed Invention

Giardino et al. teaches determining torque T by converting impulse I (col. 4, lines 29-40), not by selecting one torque expression from a set of torque expressions, as recited in the claimed invention. In Giardino et al., torque is always determined by the formula T=d(Ir)/dt (col. 4, line 40) where impulse I is always calculated as $I = \int Fdt$ (col. 4, line 11). Thus every torque pulse is analyzed, in succession, using these same two expressions. In order to accomplish the conversion of impulse I to torque T, Giardino et al. teaches the steps of: (a) equating impulse to a change in linear momentum; (b) converting linear momentum to angular momentum; and (c) equating torque to the time rate of change of angular momentum on a rigid body. See col. 4, lines 29-40. That results in the formula T=d(Ir)/dt for determining torque.

Importantly, neither the impulse nor the angular momentum equations of Giardino et al. provide a mathematical expression from which a torque expression is selected. Instead, both impulse and angular momentum equations are part of the torque expression, i.e. torque is always determined by a conversion of impulse using angular momentum. The claimed invention recites that torque is determined by selecting one mathematical expression from a set (more than one) mathematical expression. Neither the impulse nor the angular momentum equation alone determines torque. Accordingly, the impulse and angular momentum equations cannot form the basis of a set of mathematical torque expressions because neither alone defines torque.

Giardino et al. assumes that all of the information required to accurately determine torque is contained within a single equation, T=d(Ir)/dt , and does not account for variations in fastener tightness, distortion in the torque to magnetic field or magnetic field to electrical signal. Therefore, Giardino et al. teaches neither multiple mathematical torque expressions nor the ability to select one expression from the multiple mathematical expression. Thus, if the threaded joint that the tool of Giardino et al is tightening is unique in some way, that renders the torque equation of Giardino et al. inappropriate, and its output inaccurate, such that the joint will not be properly tightened.

In contrast, the claimed invention accounts for variations in threaded fastening operations, and fits, or adjusts, the equations accordingly. As described in Applicants' specification at page 10, lines 17-20 and page 11, line 19 – page 14, line 13, the equation used in the claimed invention is selected from a number of possible equations or mathematical expressions using a curve fitting function to determine the most appropriate expression. That is, the impact tool controller must first fit the data to a number of different equations to find the best one that approximates the specific pulse waveform detected for the threaded joint before the controller can determine the torque. The equation fitting process is done in real time, i.e., until the pulse waveform data are collected and the equation fitting process is complete, the actual equation to be used for calculating torque is unknown. This approach takes a number of different fastening process parameters into account (page 11, line 21 – page 12, line 4) to arrive at a more complete conclusion about the pulse waveform. This takes into account that there are variations between fasteners and their tightness after assembly.

(2) Claimed Invention Recites Selecting *One* Mathematical Expression From a Set of Mathematical Expressions

As discussed above, a determination of torque in Giardino et al. requires both the impulse and angular momentum equations. Therefore, even accepting the flawed argument that the impulse and angular momentum equations form a set of mathematical torque expressions, then two equations are selected from the alleged set, not one, as recited in the claimed invention. That is, because Giardino et al. requires both impulse and angular momentum equations to determine torque, more than one equation, two (impulse and angular momentum equations) are selected from the supposed set (formed by the impulse and angular momentum equations). In contrast, the claimed invention recites selecting one mathematical torque expression from a set of mathematical torque expressions. Because neither the impulse nor angular momentum equations together (and individually) determine torque in Giardino et al., one would necessarily have to select two equations from the alleged set of mathematical expressions, in order to determine torque.

(3) There is No Evidence That Giardino et al. is "Capable of" Having a Set of Mathematical Torque Expressions

No evidence has been provided that Giardino et al. is "capable of" having more preprogrammed sets of mathematical torque expressions. The process of "selecting" an expression requires that there be some algorithm or computer function that accepts input, performs an analysis, and then makes a decision to select a particular mathematical expression. The Examiner has not pointed to anything in Giardino et al. that teaches or suggests any of these

"selecting" steps. In fact, there is nothing in Giardino et al. to suggest that the requisite software or hardware is taught by Giardino et al.

Also, the Examiner's suggestion that Giardino et al. is "*capable* of having more preprogrammed sets of mathematical torque expressions" does not meet the test for anticipation, which is identity. Moreover, if by "capable" the Examiner means "inherent," neither evidence nor rational is provided to support that assertion. "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745, 49 U.S.P.Q.2d 1949, 1950-51 (Fed. Cir. 1999). The Examiner has provided no evidence that the step of selecting one mathematical expression from a set of mathematical expressions is necessarily present in Giardino et al.

Anticipation requires that every limitation of a claim must identically appear in a prior art reference. See *Gechter v. Davidson*, 43 U.S.P.Q. 2d 1030, 1032 (Fed. Cir. 1997). The step of selecting *one* mathematical expression from a *set* of mathematical expressions is not identically found in Giardino et al. Absence from the prior art reference of any claimed element negates anticipation. See *Rowe v. Dror*, 42 U.S.P.Q.2d 1550, 1553 (Fed. Cir. 1997).

Therefore, in view of the above, Appellants request reconsideration and withdrawal of the rejection under 35 U.S.C. 102(b), and allowance of independent claims 1, 11 and 21.

Dependent claims 2-10, 12-20 and 22-26 are also believed to be allowable for the same reasons as discussed above. Moreover, these claims recite additional features not found in

Giardino et al. For example, claims 2 and 12 recite that the equation/mathematical expression includes a parameter selected from a list of parameters. The passage in Giardino et al. (col. 4, lines 20-25) cited in the Office Action merely references t_f and discloses buffering data so that data points immediately before and after the impulse I are captured, and does not relate to the parameters recited in the claims.

E. Error to Reject Claims 4-6, 14-16 and 24-26 Under 35 U.S.C. 103(a)

Appellants submit that a prima facie case of obviousness has not been established with respect to claims 4-6, 14-16 and 24-26 because Giardino et al fails to disclose, teach, suggest or render obvious all of the limitations of independent claims 1, 11 and 21.

As discussed above, Giardino et al. fails to disclose, teach or suggest the step of fitting an equation that approximates the time-amplitude waveform of the torque pulse by selecting one mathematical expression from a set of mathematical expressions. Moreover, nothing in Giardino et al. suggests that it would have been obvious to select one equation from a set of mathematical expressions. Instead, Giardino et al. teaches that only one equation is needed, T=d(Ir)/dt, as discussed above. Accordingly, Appellants submit that dependent claims 4-6, 14-16 and 24-26 are allowable for the same reasons as discussed above with respect to claims 1, 11 and 21. Moreover, these claims recite additional features not found in Giardino et al. For example, claims 4, 5, 14, 15, and 25 recite specific equations not found in Giardino et al.

F. Conclusion

For all the reasons stated above, the Applicants-Appellants request that the Board reverse the Examiner's rejections as noted above and instruct the Examiner to confirm the patentability of the rejected claims and issue a notice of allowability.

The Commissioner is hereby authorized to charge any shortage of fees due or any overpayment of fees to BLANK ROME Deposit Account No. 23-2185 (119508-00102).

Respectfully submitted,

Tara L. Laster

Tara L. Laster
Reg. No. 46,510

Attorney for the Applicants-Appellants

BLANK ROME LLP
Watergate
600 New Hampshire Ave., N.W.
Washington, D.C. 20037
Telephone: (202) 772-5800

Date: December 3, 2007

VIII. <u>Claims Appendix</u>

The following is a list of the claims involved in the appeal in their current form.

1. **(previously presented)** A method for determining the torque applied to a fastener comprising the steps of:

applying a torque pulse to a fastener;

detecting a signal representing the time-amplitude waveform of the torque pulse;

fitting an equation that approximates the time-amplitude waveform by selecting one mathematical expression from a set of mathematical expressions and selecting at least one parameter that describes the torque pulse from a set of parameters;

processing the equation to determine the torque being applied to the fastener;

comparing the torque to a pre-set torque objective; and

applying a second torque pulse to the fastener if the torque is less than the pre-set torque objective.

2. (original) The method of claim 1, wherein the equation includes at least one parameter selected from the group consisting of the positive amplitude; negative amplitude; absolute value of the positive amplitude minus the negative amplitude; integrated area of the positive portion of the pulse curve; integrated area of the negative portion of the pulse curve; duration of the positive portion; duration of the negative portion; area from the positive amplitude to 50% of the positive amplitude; area from the negative amplitude to 50% of the negative amplitude; duration of the positive portion measured at 50% of the positive amplitude; duration of the negative portion measured at 50% of the negative amplitude; time between the start of the positive pulse and

the actual pulse peak amplitude; time between the start of the negative pulse and the actual pulse peak amplitude; and time between the peaks of the first and second torque pulses.

3. (original) The method of claim 1, wherein the equation for the torque pulse is linear.

4. (original) The method of claim 3, wherein the linear equation is represented by the formula:

$$\text{torque} = f(t) = \beta_0\, \varphi_0(t) + \beta_1\, \varphi_1(t) + \beta_2\, \varphi_2(t) + \beta_3\, \varphi_3(t),$$

wherein t is a time scale, and wherein $\beta_0 \ldots \beta_3$, are correlation coefficients and are determined using the method of least squares after collecting data from sample runs, and wherein $\varphi_0(t)$ represents the highest positive peak amplitude of the torque pulse, $\varphi_1(t)$ represents the negative peak amplitude of the torque pulse, $\varphi_2(t)$ represents the positive area of the torque pulse and $\varphi_3(t)$ represents the positive width of the torque pulse.

5. (original) The method of claim 4, wherein the correlation coefficients are determined by minimizing the function, S:

$$S = \sum_{i=1}^{n} [\, y_i - \beta_0\, \varphi_0(x_i) - \beta_1\, \varphi_1(x_i) - \beta_2\, \varphi_2(x) - \beta_3\, \varphi_3(x_i)]^2$$

6. (original) The method of claim 1, wherein the equation for the torque pulse is non-linear.

7. **(previously presented)** The method of claim 1, wherein the step of fitting an equation representing the torque pulse includes selecting at least two parameters that describe the torque pulse from the set of parameters.

8. (original) The method of claim 1, wherein the signal is produced by a magnetoelastic torque transducer associated with a shaft and an induction coils proximate the shaft.

9. (original) The method of claim 1, wherein an impact tool is used to apply the torque pulse to the fastener.

10. (original) The method of claim 1, wherein the impact tool is a pneumatic-driven torque wrench.

11. **(previously presented)** A method for determining the torque applied to a fastener comprising the steps of:

applying a plurality of torque pulses to a fastener during a fastener tightening sequence, wherein the torque pulses have a duration and amplitude;

detecting a signal representing the time-amplitude waveform shapes of each of the torque

pulses;

converting the signals into mathematical expressions representing each of the torque pulses, wherein each mathematical expressions and include parameters representing at least the amplitude and duration of the torque pulses;

processing the mathematical expressions to obtain the torque applied to the fastener during the torque pulses; and

terminating the fastener tightening sequence if the torque is approximately equal to a pre-set torque objective.

12. (original) The method of claim 11, wherein the mathematical expressions also include at least one additional parameter selected from the group consisting of the maximum positive amplitude; maximum negative amplitude; absolute value of the positive amplitude minus the negative amplitude, integrated area of the positive portion of the pulse curve; integrated area of the negative portion of the pulse curve; duration of the positive portion; duration of the negative portion; area from the positive amplitude to 50% of the positive amplitude; area from the negative amplitude to 50% of the negative amplitude; duration of the positive portion measured at 50% of the positive amplitude; duration of the negative portion measured at 50% of the negative amplitude; time between the start of the positive pulse and the actual pulse peak amplitude; time between the start of the negative pulse and the actual pulse peak amplitude; and time between successive positive peak amplitudes.

13. (original) The method of claim 11, wherein the mathematical expressions for the

torque pulses are linear expressions.

14. (original) The method of claim 13, wherein the linear mathematical expressions are represented by the formula:

$$\text{torque} = f(t) = \beta_0\ \varphi_0(t) + \beta_1\ \varphi_1(t) + \beta_2\ \varphi_2(t) + \beta_3\ \varphi_3(t),$$

wherein t is a time scale, and wherein $\beta_0 \ldots \beta_3$, are correlation coefficients and are determined using the method of least squares after collecting data from sample runs, and wherein $\varphi_0(t)$ represents the highest positive peak amplitude of the torque pulses, $\varphi_1(t)$ represents the negative peak amplitude of the torque pulses, $\varphi_2(t)$ represents the positive area of the torque pulses and $\varphi_3(t)$ represents the positive width of the torque pulses.

15. (original) The method of claim 14, wherein the correlation coefficients are determined by minimizing the function, S:

$$S = \sum_{i=1}^{n} [\, y_i - \beta_0\ \varphi_0(x_i) - \beta_1\ \varphi_1(x_i) - \beta_2\ \varphi_2(x) - \beta_3\ \varphi_3(x_i)]^2$$

16. (original) The method of claim 11, wherein the mathematical expressions for the torque pulses are non-linear.

17. (original) The method of claim 11, wherein the step of converting the signals into mathematical expressions representing the torque pulses is accomplished by selecting one mathematical expression from a set of mathematical expressions and selecting at least two parameters that describe the torque pulses from a set of parameters.

18. (original) The method of claim 11, wherein the signal is produced by a magnetoelastic torque transducer associated with a shaft and an induction coils proximate the shaft.

19. (original) The method of claim 11, wherein an impact tool is used to apply the plurality of torque pulses to the fastener.

20. (original) The method of claim 11, wherein the impact tool is a pneumatic-driven torque wrench.

21. **(previously presented)** An apparatus for producing a plurality of torque pulses during a tightening sequence of a fastener comprising:

an impact tool;

a shaft operatively connected to the impact tool;

a torque transducer coupled to the shaft;

a sensor proximate the torque transducer; and

a controller,

wherein the controller enables the impact tool, applies one or more pulses to the shaft, receives waveform signals from the sensor, monitors and conditions the signals; selects an equation that approximates the signals by selecting a mathematical expression from a set of mathematical expressions and selecting at least one parameter that describes the torque pulse from a set of parameters; processes the equation to obtain the torque on the fastener; and disables the impact tool, and wherein the equation represents the time-amplitude curve of the one or more pulses and includes parameters for the amplitude, duration and the area under the time-amplitude curve.

22. (original) The apparatus of claim 21, wherein the impact tool is a pneumatic torque wrench.

23. (original) The apparatus of claim 21, wherein the equation is linear.

24. (original) The apparatus of claim 23, wherein the linear equation is represented by the formula:

$$\text{torque} = f(t) = \beta_0\,\varphi_0(t) + \beta_1\,\varphi_1(t) + \beta_2\,\varphi_2(t) + \beta_3\,\varphi_3(t),$$

wherein t is a time scale, and wherein $\beta_0 \ldots \beta_3$, are correlation coefficients and are determined using

the method of least squares after collecting data from sample runs, and wherein $\varphi_0(t)$ represents the highest positive peak amplitude of the torque pulse, $\varphi_1(t)$ represents the negative peak amplitude of the torque pulse, $\varphi_2(t)$ represents the positive area of the torque pulse and $\varphi_3(t)$ represents the positive width of the torque pulse.

25. (original) The apparatus of claim 24, wherein the correlation coefficients are determined by minimizing the function, S:

$$S = \sum_{i=1}^{n} [\, y_i - \beta_0\, \varphi_0(x_i) - \beta_1\, \varphi_1(x_i) - \beta_2\, \varphi_2(x) - \beta_3\, \varphi_3(x_i)]^2$$

26. (original) The apparatus of claim 21, wherein the equation is non-linear.

IX. Evidence Appendix

No evidence is relied upon in the present appeal.

X. **Related Proceedings Appendix**

There are no related proceedings.